

REMARKS

Claims 1, 16 and 31 have been amended. Claims 1-3, 6-14, 16, 18, 21-29, 31 and 36-45 remain pending. Applicants reserve the right to pursue the original claims and other claims in this and other applications. Applicants respectfully request reconsideration of the above-referenced application in light of the amendments and following remarks.

Claims 1-3, 6-14, 16, 18, 21-29, 31, and 36-45 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,376,309 ("Wang") in view of Hoff, et al. "Atomic Oxygen and the Thermal Oxidation of Silicon." ("Hoff"), or Ruzylo, et al. "Evaluation of Thin Oxides Grown by the Atomic Oxygen Afterglow Method." ("Ruzylo"). The rejection is respectfully traversed.

At the outset, Applicants respectfully submit that the Office Action is not properly considering *all* of the limitations recited in claims 1, 16 and 31. Specifically, the cited references do *not* disclose or suggest that the top oxide layer in an ONO stack is formed in a *single processing step* to a thickness which is at least 60% of a targeted thickness of the oxide layer, as a result of the *single processing step*.

The Office Action states that the claim limitation, "a thickness which is at least 60% of a targeted thickness . . . is virtually meaningless because . . . the *process is repeated multiple times*." (p. 4) (emphasis added). Applicants note that claims 1, 16 and 31 recite a *single processing step*, and thus, the prior art does not teach or suggest using a *single processing step*. To expedite prosecution, Applicants have amended claims 1, 16 and 31 to emphasize the noted difference.

Accordingly, claim 1 now recites a method comprising, *inter alia*, "forming a tunnel oxide . . . forming a first conductor layer . . . forming an insulating layer . . . said insulating layer further comprising the steps of: forming a first oxide layer . . . forming a nitride layer . . . and *forming a second oxide layer . . . in a single processing step . . . with a gas ambient containing atomic oxygen, and wherein said second oxide layer formed by the single processing step results in a deposited thickness of at least 60% of a targeted thickness of the second oxide layer; [and] after said single processing step, forming a second conductor layer over said insulating layer.*" (emphasis added).

Claim 16 now recites a method comprising, *inter alia*, "depositing a first oxide layer . . . depositing a nitride layer . . . and *forming a second oxide layer . . . in a single processing step . . . using a gas ambient containing atomic oxygen, wherein . . . the second oxide layer formed by the single processing step has a deposited thickness of at least 60% of a targeted thickness of the second oxide layer, and wherein said targeted thickness is from about 20 Å to about 80 Å thick.*" (emphasis added).

Similarly, claim 31 now recites a method comprising, *inter alia*, "forming a tunnel oxide . . . forming a first conductor layer . . . forming an insulating layer . . . further comprising the steps of: forming a first oxide layer . . . forming a nitride layer . . . and *forming a second oxide layer in a single processing step . . . grown in the presence of atomic oxygen with the at a temperature of less than about 900°C for a period of about 1 second to 10 minutes, and wherein said second oxide layer is formed by the single processing step to be deposited with a thickness of at least about 60% of a targeted thickness of said second oxide layer, wherein said targeted thickness is from about 20 Å to about 80 Å thick, and said second oxide layer is deposited to be from about 12 Å to 48 Å thick; [and] after said single processing step, forming a second conductor layer over said insulating layer.*" (emphasis added).

As indicated above, Applicants' the top oxide layer is formed with a *single processing step*. Applicants' claimed method of forming the top oxide layer is *not* repeated multiple times as the Office Action asserts; but, recite that, in a *single processing step*, at least 60% of the targeted thickness of the second oxide layer is formed *in that single processing step*. Consequently, *in a single process step*, at least 60% of the targeted thickness of the oxide layer is deposited *in that single step*. Applicants' claimed methods significantly reduce the number of times a process would need to be conducted to actually achieve the desired targeted thickness for the top oxide layer in an ONO stack.

For instance, in the prior art, "the top oxide layer of an ONO interpoly dielectric layer is conventionally formed by a high temperature, wet oxidation process. Such a process involves oxidizing the nitride layer in steam and oxygen at high temperatures of about 950° C, for a long duration of time, typically about 2 hours. The lengthy oxidation process is necessary because the *actual thickness* that is deposited is *only about 1%* of the targeted thickness." (Applicants' specification, p. 6, ll. 13-20) (emphasis added). As a result, "attempting to grow a top oxide layer of about 80 Å, *only about .8 Å will actually grow* on the nitride layer." (Applicants' specification, p. 6, l. 20 through p. 7, l. 1) (emphasis added).

Applicants' claimed methods relates to solving these problems associated with prior art methods. "As a result of the conditions used to form the top oxide layer 46c, the resulting oxide layer will be at least about 60% of the targeted thickness of the top oxide layer on the nitride layer 46b [when a *single process step* is performed], as compared to a typical thickness of about 1% to about 3% of the targeted thickness in a conventional method, such as wet oxidation, not utilizing atomic oxygen." (Applicants' specification, p. 14, ll. 2-7). Thus, when applying Applicants' claimed methods, and "[d]epending on the targeted thickness, for instance 80 Å, the thickness of the top oxide layer is about 48 Å," *after a single process step* with atomic oxygen is employed

(Applicants' specification, p. 13, ll. 17-20).

In fact, Applicants respectfully submit that Wang merely discloses a *conventional* wet oxidation process to form the top oxide layer in an ONO structure. This fact is underscored by the Office Action's acknowledgment that "Wang et al. *fails to show* forming the second oxide layer using an oxidizing ambient in atomic oxygen to form the oxide layer with a thickness of 60% of a targeted thickness and at various temperatures and times." (Office Action, p. 3) (emphasis added).

With regard to independent claims 1, 16, and 31, the Office Action next relies upon Hoff or Ruzyllo for disclosing an oxidizing ambient using atomic oxygen. The Office Action further asserts that the processes in Hoff and Ruzyllo would allow for oxide growth, in Wang, at low temperatures with high breakdown values; and thus, motivation is provided for combining either reference with Wang. Applicants respectfully disagree.

Employing atomic oxygen, in Wang, would *increase* the gate aspect ratio which *directly contradicts* the purpose of Wang. The idea of forming a thicker ONO structure is completely contrary to the problem that Wang is directed to solving: *reducing the gate aspect ratio of a flash memory device*. For example, in Hoff, films that were grown in the afterglow method using atomic oxygen at a high temperature, were *overall thicker* than those grown in the thermal mode alone (p. 2, ¶2). A thicker ONO structure *increases* the gate aspect ratio and thus, an atomic oxygen process would *not* be desirable in Wang. Accordingly, one skilled in the art would not be motivated to combine Hoff or Ruzyllo's atomic oxygen process with Wang since it would increase the gate aspect ratio rather than decrease it; thereby, completely contradicting Wang's teachings.

Moreover, Hoff admittedly may suggest that atomic oxygen can be used to decrease the temperatures required for conventional oxidation. However, Ruzyllo further discloses that atomic oxygen can be used for oxidation temperatures *as low as* 400°C. In other words, even if the references are properly combinable, which they are not, they would disclose an oxidation temperature of around 400°C and *not* Applicants' claimed temperature "of about 850°C to about 1100°C," as recited in claim 16, or "at a temperature of less than about 900°C," as recited in claim 31. Ruzyllo's 400°C is significantly less than Applicants' claimed temperature range for forming the second oxide layer in an ONO stack.

The Office Action further asserts that "the claim [1, 16, and 31] fails to describe how the targeted thickness is determined, so if one knows that the thickness of an oxide will be 60% of a targeted thickness then the examiner fails to see why the targeted thickness could not be 60% of the first targeted thickness when giving the claim its broadest interpretation." (Office Action, p. 4). At the outset, Applicants respectfully note that the claims recite a *single processing step* in which the targeted thickness is achieved.

Moreover, Applicants respectfully submit that, in the prior art, a lengthy oxidation process was necessary because the *actual thickness* of the top oxide layer that was deposited was *only about 1%* of the targeted thickness (Applicants' specification, p. 6, ll. 18-20). As a result, growing a top oxide layer required *many* multiple processes to form the desired thickness. In contrast, Applicants' claimed method allows a *single process* step to be used to form a second oxide layer that is 60% of a targeted thickness of the second oxide layer's desired thickness; thereby greatly reducing the number of processes required to form the desired second oxide layer's thickness. The targeted thickness is given a definite parameter in the claims. At least 60% of between 20 Å to about 80 Å of a second or top oxide layer will be grown in a single process step by

applying Applicants' claimed methods.

The Office Action next asserts that "[w]ith respect to the particular time and temperature of the oxidation, it would have been obvious to determine through routine experimentation the optimum time and temperature to conduct the oxidation process based upon a variety of factors including the desired thermal budget and would not lend patentability to the instant application absent the showing of unexpected results (Office Action, p. 3).

Applicants respectfully submit, however, that the Office Action fails to set forth a *prima facie* case of obviousness. See M.P.E.P. § 2142. In particular, *none* of the cited references, alone or in combination, teaches or suggests Applicants' claimed time and temperatures for growing a top oxide layer. To establish *prima facie* obviousness of a claimed invention, *all* the claim limitations must be taught or suggested *by the prior art*." M.P.E.P. § 2143.03 (emphasis added). It is *inappropriate* to merely conclude that these parameters can be determined through routine optimization.

All of the references are completely silent with regard to time and temperature. The cited references do not teach or suggest, *inter alia*, "forming a second oxide layer in a *single processing step*. . . at a temperature of about 850°C to about 1100°C, for about 1 second to about 10 minutes," as recited in claim 16 (emphasis added), or growing a second oxide layer in a *single processing step* "at a temperature of less than about 900°C for a period of about 1 second to 10 minutes," as recited in claim 31.

Moreover, even if the references could somehow be combined, despite any motivation to do so, it is well-settled that "[t]he mere fact that references can be combined or modified *does not* render the resultant combination obvious unless the prior art also *suggests* the desirability of the combination." M.P.E.P. § 2143.01

(emphasis added).

The prior art is *not* suggesting the proposed combination; but, rather the claimed invention is the foundation for the combination. As noted above, the references teach away from each other since using atomic oxygen in Wang would *increase* the gate aspect ratio which is completely contrary to the problem that Wang is directed to solving: *reducing the gate aspect ratio*. The proposed combination is improper hindsight reconstruction.

This fact is underscored by M.P.E.P. § 2143.02, which indicates that “[a] statement that modifications of the prior art to meet the claimed invention would have been ‘well within the ordinary skill of the art’ at the time the claimed invention was made because the references relied upon teach that all aspects of the claimed invention were individually known in the art is *not sufficient* to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references.” (emphasis added).

The Office Action states that “the upper oxide layer in Wang is being replaced by the oxide layer as shown in Huff or Ruzylo and therefore any reference to the top oxide layer in Wang is improper.” (p. 5). Again, Applicants respectfully submit that there must be *some motivation* to substitute Wang’s top oxide layer with another oxide layer. In this case, there is *no* motivation. Wang relates to reducing the gate aspect ratio of a gate stack structure. Employing Huff or Ruzylo’s oxide layer would *still* yield a *thicker* gate stack structure which would increase the gate aspect ratio in Wang: completely defeating the very purpose of Wang. There simply is no objective reasoning to combine Wang with Hoff or Ruzylo where the proposed combination would increase the gate aspect ratio in Wang.

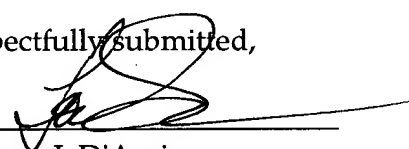
Claims 2-3 and 6-14 depend from claim 1, claims 18 and 21-29 depend from claim 16, and claims 36-45 depend from claim 31. These dependent claims should be allowable for at least the reasons set forth above regarding their independent base claims, and on their own merits.

Moreover, the cited references do not disclose or suggest a method where the "second oxide layer is grown at a temperature of about 850°C to about 1100°C," as recited in claim 2. As discussed above, the cited references are completely *silent* about any temperatures relating to a process using atomic oxygen to grow a second oxide layer. Similarly, the cited references fail to disclose or suggest a method where the "second oxide layer is grown at a temperature of less than about 900°C," as recited in claim 3 and independent claim 16. These are additional reasons for the allowance of the claims.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to review and to pass this application to issue.

¹⁸
Dated: November ~~22~~, 2005

Respectfully submitted,

By 
Thomas J. D'Amico
Registration No.: 28,371
DICKSTEIN SHAPIRO MORIN &
OSHINSKY LLP
2101 L Street NW
Washington, DC 20037-1526
(202) 785-9700
Attorney for Applicants